

The control systems and procedures employed by the Enbridge Control Center to operate and protect Line 5 are designed and optimized to prevent the release of hydrocarbons into the environment. These systems are fully supported by redundant leak detection regimens that monitor the pipeline 24/7 for leak triggers to restrict the volume of a release in the rare event of an unintended system failure. Taken together, these systems, processes and procedures constitute a proactive, comprehensive risk based approach that exemplifies the commitment Enbridge has made to deliver energy, safely and reliably, to millions of North Americans every day.

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## PIPELINE CONTROL

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Enbridge opened a new and improved Control Center in Edmonton, Alberta in 2011. The new control center work environment is specifically designed to enhance the safety and reliability of our pipeline operations by creating the optimal conditions to support our operators as they conduct critical around-the-clock operations.

The new facility allows for greater interaction and enhanced support for Enbridge 24/7 operations and is designed to address fatigue management and maximize human performance through such features as sit/stand consoles, improved lighting and noise reduction. In addition to the new facility and technology, over the last two years Enbridge has made numerous enhancements to Control Center Operations (CCO), including:

- Developed and implemented a Control Room Management plan, including improvements to: roles and responsibilities, alarm management, training, and safety culture.
- Revised and enhanced all procedures pertaining to decision-making, managing pipeline startups and shutdowns, leak detection system alarms, communication protocols, and suspected column separations.
- Enhanced the organizational structures to better support our controllers and to manage span of control and workloads.
- Augmented CCO staff, adding training, technical support, engineering and controller positions, including new on-shift, 24/7 technical advisory positions.

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## SCADA AND CONTROL SYSTEMS

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Enbridge's Supervisory Control And Data Acquisition (SCADA) system has been designed to provide redundancy of SCADA systems and associated hardware within each control center and a redundancy of control centers through the implementation of a fully capable backup control center. The telecommunications system used to monitor and control the pipeline facilities uses a combination of wide area network, telephone line, satellite communication circuits and radio communications to remote terminal units (RTUs) and/or programmable logic controllers (PLCs) at all terminals, pump stations and automated valve locations along the pipeline.

Enbridge's SCADA system provides the operators with displays, trends, reports, and alarms to enable effective and efficient control of the pipeline and alerts the operator to abnormal conditions like unexpected drops in pressures or increases in flow rates. In addition to the SCADA System,

Enbridge has implemented automatic backup pressure protection through a number of methods, including an extension to the Line Pressure Monitor ("LPM") alarm system. The LPM alarm system monitors station discharge and suction pressures and can initiate set-point reductions, unit shutdowns, or entire line shutdowns as necessary to avoid overpressure situations.

Along the pipeline, each pump station's control system is comprised of instrumentation and electrical devices that are all connected to a Programmable Logic Controller (PLC). The PLC's main function is to control, monitor and protect the station and various electrical equipment from overpressure, surges, abnormal operating conditions, and other anomalies by shutting down and locking out the appropriate equipment in order to protect the environment, facilities, public and station personnel. Depending on the problem encountered, the PLC will either shutdown individual mainline pumps, isolate individual mainline pumps by closing valves and opening up power sources, or isolate the entire station by closing valves, shutting down all of the mainline pumps, and de-energizing until someone is called out to the site to investigate. This information is monitored 24/7 by the Pipeline Operators through the SCADA system.

The Straits of Mackinac facility has redundant systems that will ensure communication and valve actuation are available in the event of a main power interruption.

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## LEAK DETECTION

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Leak Detection is critical to safe pipeline operations. The leak detection systems and other overlapping methods are used to notify the pipeline operator of the potential leak condition. Once notified, the operator follows procedure to support the analysis of the alarm by notifying the Leak Detection Analyst and identifies if hydraulic conditions support invoking the emergency procedures that shut down and isolate appropriate sections of the pipeline. These actions are taken to minimize environmental impact and to ensure the safety of the people living in the communities where we operate.

Enbridge is committed to applying industry best practices, employing proven technologies, ensuring comprehensive processes guide critical work activities, and personnel are trained and competencies are assessed. Enbridge commits to performing the following on all pipeline systems, including line 5:

- The Enbridge pipeline system will not be operated without a functioning Leak Detection System, for all modes of operation.
- All leak alarms are presumed to be valid and are acknowledged, analyzed, and evaluated.
- Qualified personnel are trained in accordance with industry standards and applicable regulations. Personnel are specifically trained to use and operate Enbridge's Leak Detection Systems to evaluate and analyze pipeline hydraulics and potential leaks. The Pipeline Controllers are equipped with a support structure to assist with leak analysis and support of the associated software and hardware systems.

Enbridge is also committed to continuous improvement of its leak detection strategy, which is a comprehensive, multi-layered approach for its pipeline network. Enbridge monitors pipelines for possible leaks using four primary methods, each with a different focus and featuring differing technology, resources and timing. Used together, these methods provide multiple layers of protection and comprehensive leak detection capabilities.

- **Monitoring.** Enbridge's Pipeline Controller monitors pipeline conditions 24/7 (such as pipeline pressure) through the Supervisory Control and Data Acquisition (SCADA) system, which is designed to identify and raise an alarm in response to unexpected operational changes such as pressure drops, which may indicate a leak.
- **Visual surveillance and odor reports.** These are visual reports of oil or unusual hydrocarbon based odors reports provided by third parties and from Enbridge's aerial and ground line patrols. Third-party reports are handled through a toll-free 1-800 emergency telephone line, which the public and local emergency officials are made aware of through Enbridge's public awareness programs. Enbridge typically conducts aerial line patrols every two weeks on its entire system.
- **Scheduled line-balance Calculations.** Enbridge calculates oil inventory at fixed intervals, typically every two and every 24 hours, to identify unexpected losses of pipeline inventory that may indicate a possible leak.
- **Computational pipeline monitoring (CPM)** CPM is a computer-based system that utilizes measurements and pipeline data to detect anomalies that could indicate possible leaks. The CPM system provides a sophisticated computer model of Enbridge's pipelines that continuously monitors changes in the calculated volume of oil between two fixed points on the system. If the calculated volume of oil is less than expected, then an alarm is triggered in Enbridge's Control Center. The cause of the alarm is investigated immediately.

Enbridge also periodically makes use of Acoustic Inline Inspection tools (Smart PIGS). In addition to a comprehensive Integrity Management plan, the application of acoustic inline inspection tool technology helps detect anomalous acoustic activity associated with pipeline leaks. In essence, the PIGS are tuned to 'listen' for leaks. This method has detection thresholds well below that of real time software based methods, and as such can be used to augment visual and other inspection methods to periodically confirm the integrity of the pipeline.

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## IMPROVEMENTS TO LEAK DETECTION

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Enbridge continuously improves its capability to detect leaks on its pipelines. Over the last several years, Enbridge has focused significant time and resources in several areas to improve overall capability and system performance:

- Enhancement of procedures for leak analysis
- Enhancement of training program for leak analysis "experts"
- Enhancement of the Computational Pipeline Monitoring system through the introduction of new methods that dynamically set alarm thresholds to match the operating condition of the pipeline

- Software tuning and performance enhancement of the computational pipeline monitoring system through capital investment of adding new instrumentation to our pipelines, including line 5 (see below)
- Focused research of commercially available leak detection technologies followed with production pilots of selected technologies

The Leak Detection Instrumentation Improvement program adds new ultrasonic flow meters and other pipeline instrumentation aimed at improving the performance of the Leak Detection system across all Enbridge pipeline systems. This program has introduced 3 ultrasonic meters on Line 5, with an additional 3 meters, 2 ground temperature sensors, and one viscosity meter planned for installation in 2014.

Focus continues on Leak Detection initiatives to improve system sensitivity, reliability, accuracy and robustness. Since 2011, changes introduced to the leak detection system for Line 5 resulted in significant improvements in system reliability and sensitivity. Further improvement of CPM reliability continues to be a focus for the area, with 2014 (year to date) seeing additional reliability improvements. In 2013, Leak Detection Analysts in the control center underwent additional training including team based training and unannounced fluid withdrawal tests-.

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## NEW TECHNOLOGY DEPLOYMENT

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Enbridge is committed to continuous research and testing of new commercially available Leak Detection technologies to ensure the most appropriate technologies are in place. Key (complete and active) initiatives supporting this commitment are:

- Assessment of Inline Acoustic Leak Detection Technologies. Status: Complete with selected technology utilized as required on various pipelines
- Assessment of complementary CPM systems. Status: In-Progress - These assessments will determine if a second CPM will complement and enhance the overall CPM system sensitivity, reliability, accuracy and robustness capabilities. Enbridge is executing a complementary CPM production pilot in 2014 as the current phase of this assessment.
- Assessment of external leak detection sensors. Status: In-Progress - Since 2011, Enbridge has completed design and construction of an External Leak Detection Experimental Research (ELDER) test apparatus. The ELDER apparatus is the first tool of its kind in the world of this scale, and was purpose-built to evaluate external leak detection technologies. The apparatus is being used to identify the best external leak detection technologies on the market, and that information will ultimately improve pipeline safety across the industry. A Joint Industry Partnership has been established and testing is in underway to determine the effectiveness of these technologies under a variety of conditions and leak rates.